

The Application of Underbalanced Drilling Technology in Petroleum Exploitation

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Abstract: Petroleum plays an important role in the development of modern social economy. There are abundant petroleum resources in our country, but for the characteristics of petroleum reservoir itself, the drilling quality is always not very high. In the whole activities of petroleum exploitation and development, the main investment concentrates in the well drilling. From the perspective of drilling cost, the application of underbalanced drilling technology can improve drilling speed, reduce drilling cost, prevent petroleum reservoir pollution, enhance oil well productivity, and increase the overall economic benefits of exploitation and development. The researches and applications of this technology have very important practical significance.

Keywords: Petroleum, Drilling, Underbalanced drilling technology, Economic benefits

I . INTRODUCTION

China has become one of the petroleum production and consumption great powers in the world currently. With the increased dependence on imported petroleum, the changes in international petroleum markets and the fluctuation of international petroleum prices are bringing greater influence and impact to the petroleum industry and economic development, so it is necessary to increase the efficiency of petroleum resources in our country. The drilling costs account for 70 % of the costs of the petroleum exploitation and development. In order to improve the efficiency of petroleum exploitation, drilling method should be taken into account firstly. Underbalanced drilling technology is a developing drilling technology from the end of 20th century .It allows the circulating mud pressure lower than the formation pressure, and allows the formation fluid flows into the borehole and to the ground under effective control. At present, under-balanced drilling are actively carried out in America, Canada and Norway. In recent years, our country introduced main equipments for the experimental study of under-balanced drilling .The test experiments were carried in appropriate strata in several oilfields, and preliminary experiences and effects were obtained. Experts get the conclusion that this technology has significant advantage in reducing comprehensive drilling cost.

II . THE CONCEPT OF UNDERBALANCED DRILLING TECHNOLOGY

Drilling is the only way to realize the development of

petroleum. The petroleum can be transported to the ground only through the drilling borehole. To prevent blowout, conventional drilling belongs to overbalanced drilling, the circulating mud pressure is higher than the formation fluid pressure and lower than the formation fracture pressure. So the under-balanced drilling is a unique drilling technology.

Underbalanced drilling technology which means the fluid column pressure in the well bore is lower than formation fluid pressure while drilling and the negative pressure value is controlled artificially, during the procession of drilling, the formation fluid is allowed to circulate to the ground throughout the borehole and is controlled on the ground finally.

III. KEY TECHNOLOGIES AND ADVANTAGES OF UNDERBALANCED DRILLING

A. Key Technologies

1) Negative pressure

Adjust the density of drilling mud to control fluid column pressure is lower than formation pressure, use rotary blowout preventer and throttling manifold system to control back pressure on the wellhead, so carry out the negative drilling artificially furthermore. The negative pressure value is the differential numerical value between fluid column pressure on bottom hole and formation pressure. It means that exert the back pressure equivalent to the differential numerical value by the wellhead can offset formation pressure, which is one of the key technologies to carry out the underbalanced drilling safely. If the designed negative pressure value is too low, the underbalanced drilling will not be carried out, vice versa, If the designed negative pressure is too high, it is easy to cause well blowout accident for the well control equipments overloading. The negative pressure value is not definite, when the density of formation fluid is too low, using the drilling mud which density is lower than 1.0g/cm^3 may be is not underbalanced drilling, but when the formation pressure coefficient is lower than 1.0, low density drilling mud is indispensable.

2) Petroleum separation

The formation fluid flows into the well bore under the condition of the negative pressure. The petroleum and drilling mud are separated by the liquid-gas separator on the ground. For the restrictions of the ground condition, the velocity and volume of the overflowing fluid should be

controlled strictly.

B. Advantages

1) Underbalanced drilling is helpful to discover petroleum reservoirs early

Overbalanced drilling usually causes certain degree of damage to the formation, sometimes the petroleum show is supposed to appear but it does not, so the petroleum exploitation is influenced furthermore. But under the condition of underbalanced drilling technology, the formation fluid can flow into the well bore in the process of drilling, supervising the returning fluid on the wellhead can reflect the information on petroleum reservoir, so it is helpful to achieve the determination of petroleum exploitation. And it provides useful information for drilling operation itself to adjust the drilling measures and ground operational methods timely. Additionally, it can improve the safety of drilling operation.

2) Improve drilling speed greatly

The tri-axial stress states of rocks in the bottom hole are changed under the condition of under-balanced drilling. It is helpful for the bit to break up rocks and reduce chip hold down effect, meanwhile, it can avoid the phenomenon of repeat cutting. So it can improve rock cutting efficiency and improve the penetration rate and service life of bit, shorten the well construction period, reduce the comprehensive cost of well construction.

3) Decrease well leakage and prevent petroleum reservoir pollution

Conventional overbalanced drilling technology will

C. An example

Table 1 Underbalanced Drilling Technology Used in T—K56 Well in Tarim Oil Field

| Well number | Oil field | Designed well depth (M) | Drilling method | Well construction period (H) | Average drilling speed (M/P) | Cost of drilling mud (¥1000) | Total consumption cost (¥1000) |
|-------------|-----------|-------------------------|------------------------|------------------------------|------------------------------|------------------------------|--------------------------------|
| T—S88 | Tarim | 5 847 | Conventional drilling | 1 560 | 3.748 | 4 810.4 | 47 225.8 |
| T—K56 | Tarim | 6 235 | Underbalanced drilling | 1 080 | 5.773 | 1 972.6 | 31 062.5 |

Notes: M-Meters; H-Hour; M/P- meter per hour;

According to the above table, T—S88 and T—K56 are adjacent wells in the same area. T—S88 was drilled by conventional drilling method firstly. The data from measure while drilling in T—S88 showed that formation pressure in this area was single and under-balanced drilling technology was suitable for this strata. Consequently underbalanced drilling was taken into consideration in T—K56. As shown in the above table, compared with T—S88, well construction period was shortened by 31.8%, drilling speed was improved to 154%, cost of drilling mud economized reached to 2 837.8 thousand Yuan and total consumption cost was saved 1 6163.3 thousand Yuan.

V. LIMITATIONS OF UNDERBALANCED DRILLING TECHNOLOGY

inevitably cause the drilling mud to leak slightly. In the easily leakage strata, the leakage will cause plenty of drilling mud to flow into the strata. It will not only induce complicated underground accidents, but also cause great economic loss for the leakage of drilling mud, and the leaked drilling mud will contaminate the petroleum reservoir, so the exploitable amount of petroleum reservoir will decrease finally. But underbalanced drilling technology can solve all those problems by greatly decreased occurrence rate of leakage.

IV. UNDERBALANCED DRILLING TECHNOLOGY AND DRILLING COST

A. Improvement of drilling speed can reduce the cost of percent drilling footage

Because of the improvement of drilling speed, the same well depth, the time needed is shorter, so the cost of percent drilling footage is greatly reduced.

B. Decrease the occurrence probability of leakage and reduce the comprehensive cost of well construction

The comprehensive cost of well construction includes the cost of bits and drilling rig, wages for workers, management and the cost of drilling mud. If the mud is leaked too much, obviously it will waste a lot of money. The lower of occurrence probability of leakage, the more money on the comprehensive cost of well construction will be saved.

A. Its utilization depends on the pressure of petroleum reservoir

If the pressure of petroleum reservoir is too high, the petroleum output ratio in unit time is large. Under this condition, if underbalanced drilling technology is carried out, monitoring of the petroleum output velocity and volume is very difficult.

B. Its application is restricted by the formation pressure systems

Different formation pressure systems coexist in the same borehole, and the pressure systems have great disparity. If the high pressure stage is taken into consideration, the

phenomenon of leakage will appear in the low pressure stage. To reduce possibility of leakage in the low pressure stage, the wellhead back pressure will exceed safety range. So underbalanced drilling will be forced to give up under this condition. Specifically speaking, underbalanced drilling should not be taken into practice under the condition of complicated formation pressure systems.

VI. CONCLUSION

- 1) To prevent leakage of formation, improve drilling speed, protect petroleum reservoir and increase single well production rate, underbalanced drilling technology is one of the most effective methods up to now.
- 2) In the process of underbalanced drilling, confirm negative pressure value accurately is the key technology to carry out this drilling method.
- 3) Underbalanced drilling technology is not suitable for all strata. If formation pressure system is complicated in the same borehole, underbalanced drilling technology should not be taken into consideration under this condition.
- 4) Underbalanced drilling technology used in coiled tubing drilling (CTD) has relative higher drilling efficiency. It does not need drilling pipe in the process of drilling and negative pressure value can be always kept stationary. For these advantages, drilling safety is improved greatly. So underbalanced drilling technology used in CTD is suitable for high pressure formation in which common underbalanced drilling technology is not fit for using. This technology has great potentiality to be popularized in recent years.

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